

## IRRIGATION: UNITED STATES

## ABSTRACT—FARMS AND ACREAGE IRRIGATED, IRRIGATION WORKS, COST OF CONSTRUCTION, COST OF OPERATION AND MAINTENANCE, AND CROPS GROWN UNDER IRRIGATION

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[Reprint of Chapter 14, pages 421-432 of the Abstract of the Thirteenth Census.]

## INTRODUCTION.

This chapter contains, in condensed form, the principal data regarding irrigation derived from the Thirteenth Decennial Census, taken in the year 1910.

An amendment to the Thirteenth Census act, approved February 25, 1910, contained the following clause relating to irrigation:

Inquiries shall also be made as to the location and character of irrigation enterprises, quantity of land irrigated in the arid region of the United States and in each state and county in that section under state and Federal laws; the price at which these lands, including water rights, are obtainable; the character and value of crops produced on irrigated lands, the amount of water used per acre for said irrigation and whether it was obtainable from national, state, or private works; the location of the various projects and methods of construction, with facts as to their physical condition; the amount of capital invested in such irrigation works.

As the Office of Experiment Stations of the United States Department of Agriculture employs a corps of state irrigation agents, an arrangement was made by which these state irrigation agents cooperated in the supervision in their respective states of the work of the special agents of the Bureau of the Census in collecting statistics of irrigation.

The information called for by this law which could be supplied by farm operators was obtained on supplemental schedules by the regular census enumerators as a part of the agricultural census. The remaining data, which were supplied by the owners or officials of irrigation enterprises, were obtained on special schedules by the special agents. The data relating to crops presented here were taken from the supplemental schedules filled out by the agricultural enumerators. With the exception of the statistics as to the number of farms irrigated, which were obtained as explained on the following page, all the other data presented here were taken from the special schedules.

The law relating to the special irrigation census, quoted above, provided that the inquiry should cover the "arid region of the United States." For the purposes of this report the "arid region" has been held to include all sections of the United States where irrigation is generally practiced in the growing of farm crops.

As defined in this way, the "arid region" includes the western parts of the tier of states formed by the

Dakotas, Nebraska, Kansas, Oklahoma, and Texas, and all of the states between these and the Pacific Ocean. In parts of this great territory there is abundant rainfall; but in each of the states comprised in it there are considerable sections, and in some very extensive areas, where farming is largely dependent upon irrigation.

The special inquiry was also extended to the rice growing districts of Louisiana, Texas, and Arkansas, but the rice district has been treated separately in this report. (See p. 431.)

In accordance with the law, the enterprises have been classified primarily according to their legal status—that is, according to the state or Federal laws by virtue of which they were created, or according to other features of their legal and economic form. The types of enterprises distinguished are as follows:

**United States Reclamation Service enterprises**, established under the Federal law of June 17, 1902, providing for the construction of irrigation works with the receipts from the sale of public lands.

**United States Indian Service enterprises**, established under various acts of Congress providing for the construction by that service of works for the irrigation of land in Indian reservations.

**Carey Act enterprises**, established under the Federal law of August 18, 1894, granting to each of the states in the arid region 1,000,000 acres of land on condition that the state provide for its irrigation, and under amendments to that law granting additional areas to Idaho and Wyoming.

**Irrigation districts**, which are public corporations established under state laws and empowered to issue bonds and levy and collect taxes for the purchase or construction of irrigation works.

**Cooperative enterprises**, which are controlled by the water users combined in some organized form of cooperation under state laws. The most common form of organization is the stock company, the stock of which is owned by the water users. In Arizona and New Mexico many of the cooperative enterprises are operated under laws regulating "community" ditches.

**Individual and partnership enterprises**, which belong to individual farmers, or to groups of farmers associated without formal organization. It is not always possible to distinguish between partnership and cooperative enterprises; but as the difference is slight this is unimportant.

**Commercial enterprises**, incorporated or otherwise, which supply water for compensation to parties who own no interest in the works. Persons obtaining water from such enterprises are usually required to pay for the right to receive water and to pay, in addition, annual charges based in some instances on the acreage irrigated and in others on the quantity of water received.

## THE ARID REGION AS A WHOLE.

**Summary.**—Table 1 summarizes the principal data for the arid region as a whole as returned at the census of 1910, and includes corresponding data for the preceding census as far as available. Unless otherwise indicated the figures relate to the year in which the census was taken. In the reports of the censuses of 1900 and 1890 data relating to irrigation on Indian reservations were excluded from the totals for the arid region, but for the later census they are included. Since the acreage which was irrigated on Indian reservations in 1909 was only 172,912, or 1.3 per cent of the total acreage reported as irrigated, it has not been deemed advisable to eliminate the figures for Indian reservations in making comparisons between the different censuses. The general agricultural statistics given in the table for purposes of comparison cover the entire areas of the states included in the arid region, as defined on the preceding page, although in some of the states the territory which requires no irrigation vastly exceeds the irrigated territory.

The number of farms irrigated is the number of farms on which irrigation is practiced, regardless of the extent of such irrigation, and is equivalent to the term "number of irrigators" used in previous census reports. The number given for 1909 is made up of the number reported on the supplemental agricultural schedules by

the regular enumerators, together with an estimate of the number of farms served by enterprises which were reported by special agents but not by the regular enumerators. The reports of the special agents stated only the acreage supplied by such enterprises, and the number of farms was estimated on the basis of the average acreage irrigated per farm, as shown by the supplemental schedules.

The acreage irrigated in 1909 is that reported by the special agents from information secured from owners or officials of irrigation enterprises or, in some instances, from public records. This acreage is probably in some measure an overstatement. There is a natural tendency for the officials of irrigation enterprises to report as irrigated the entire areas of farms of which only a part is irrigated. Furthermore, some farms receive water from more than one enterprise, and may be reported as irrigated by each, which results in duplication. It is believed, however, that the acreage given is within 10 per cent of the correct figure. In addition to information as to the acreage irrigated in 1909 data were collected as to the acreage the enterprises were capable of supplying with water in 1910 and the total acreage which enterprises completed or under way in 1910 were designed to supply ultimately (designated as "acreage included in projects").

Table 1	CENSUS OF—		INCREASE.	
	1910	1900	Amount.	Per cent.
Number of farms <sup>1</sup> .....	1, 440, 822	1, 095, 675	345, 147	31. 5
Approximate land area <sup>1</sup> ..... acres..	1, 161, 385, 600	1, 161, 385, 600		
Land in farms <sup>1</sup> ..... acres..	388, 606, 991	348, 780, 221	39, 826, 770	11. 4
Improved land in farms <sup>1</sup> ..... acres..	173, 433, 957	119, 709, 592	53, 724, 365	44. 9
Number of farms irrigated.....	<sup>2</sup> 158, 713	<sup>3</sup> 107, 489	51, 224	47. 7
Acreage irrigated.....	<sup>2</sup> 13, 738, 485	<sup>3</sup> 7, 518, 527	6, 219, 958	82. 7
Acreage enterprises were capable of irrigating.....	19, 334, 697	( <sup>4</sup> )		
Acreage included in projects.....	31, 111, 142	( <sup>4</sup> )		
Number of enterprises.....	54, 700	( <sup>4</sup> )		
Total length of ditches..... miles..	125, 591	( <sup>4</sup> )		
Length of main ditches..... miles..	87, 529	( <sup>4</sup> )		
Length of lateral ditches..... miles..	38, 062	( <sup>4</sup> )		
Number of reservoirs.....	6, 812	( <sup>4</sup> )		
Capacity of reservoirs..... acre-feet..	12, 581, 129	( <sup>4</sup> )		
Number of flowing wells.....	5, 070	( <sup>4</sup> )		
Number of pumped wells.....	14, 558	( <sup>4</sup> )		
Number of pumping plants.....	13, 906	( <sup>4</sup> )		
Capacity of power plants..... horsepower..	243, 435	( <sup>4</sup> )		
Acreage irrigated with pumped water.....	<sup>2</sup> 477, 625	( <sup>4</sup> )		
Acreage irrigated from flowing wells.....	<sup>2</sup> 144, 400	( <sup>4</sup> )		
Cost of irrigation enterprises.....	\$307, 866, 369	<sup>5</sup> \$66, 962, 275	\$240, 904, 094	359. 8
Average cost per acre.....	<sup>6</sup> \$15. 92	<sup>7</sup> \$8. 91	( <sup>8</sup> )	
Average cost of operation and maintenance, per acre.....	<sup>2</sup> \$1. 07	<sup>3</sup> \$0. 38	\$0. 69	181. 6

<sup>1</sup> Figures relate to entire areas of states in the arid region, the figures for 1900 including Indian Territory.

<sup>2</sup> Cost of systems operated in 1899.

<sup>3</sup> In 1909.

<sup>4</sup> Based on cost to July 1, 1910, and acreage enterprises were capable of irrigating in 1910.

<sup>5</sup> In 1899.

<sup>6</sup> Figures not comparable. (See explanation in text.)

<sup>7</sup> Not reported.

The number of farms on which irrigation was practiced, for purposes other than rice growing, in 1909 in the states of the arid region was 158,713, or 11 per cent of the total number of farms in the same states

While the total number of farms in this region, including the entire area of states in which irrigation is practiced in the western part, increased 31.5 per cent between 1900 and 1910, the number of farms on

which irrigation was practiced increased 47.7 per cent between 1899 and 1909, the irrigated farms forming a larger percentage of all farms in 1909 than in 1899. The acreage reported as irrigated in 1909 was 13,738,485, which constitutes 1.2 per cent of the total land area of the same states, 3.5 per cent of the total land in farms, and 7.9 per cent of the improved land in farms. There was an increase of 82.7 per cent in such acreage between 1899 and 1909, a rate of increase much higher than that in the number of farms irrigated, the average irrigated acreage per farm being greater for 1909 than for 1899.

The acreage to which enterprises were ready to supply water in 1910 was 19,334,697, or 5,596,212 acres in excess of the acreage irrigated in 1909, while the acreage included in all projects in 1910, whether completed or in process of development, was 31,111,142, or 17,372,657 acres greater than the acreage reported as irrigated in 1909.

The total length of ditches used for irrigation in 1910 was 125,591 miles. There were 6,812 reservoirs hav-

ing a combined capacity of 12,581,129 acre-feet, or nearly 1 acre-foot of reservoir capacity for each acre irrigated from any source in 1909. The number of pumping plants reported was 13,906 and the acreage supplied by them 477,625.

The total cost of irrigation enterprises to July 1, 1910, was \$307,866,369, or \$15.92 per acre of the land which these enterprises were capable of supplying with water in 1910. The increases in the items relating to cost are the most conspicuous shown. The total cost of irrigation enterprises increased between 1900 and 1910 by 359.8 per cent, and the average cost per acre covered increased also, although much less in degree. (As to the comparability of the figures for this item, however, see the discussion of this subject following Table 12.) The average cost of operation and maintenance per acre of land irrigated for the year 1909 shows also a large increase—181.6 per cent—over the cost shown for 1899. It is believed, however, that the cost shown for 1899 is not properly comparable with that for 1909.

### FARMS AND ACREAGE IRRIGATED.

**Number of farms irrigated.**—Table 2 gives, by states, the number of farms irrigated in 1909, 1899, and 1889, together with the decennial rates of increase.

STATE.	FARMS IRRIGATED.					
	1909	1899	1889	Increase. <sup>1</sup>		
				1899-1909		1889-1899
				Number.	Per cent.	Per cent.
Total .....	158,713	107,489	54,136	51,224	47.7	98.6
Arizona .....	4,841	2,981	1,075	1,860	62.4	177.3
California .....	39,352	25,611	13,732	13,741	53.7	86.5
Colorado .....	25,857	17,613	9,959	8,244	46.8	82.3
Idaho .....	10,439	8,987	4,323	7,452	82.9	107.9
Kansas .....	1,006	929	519	77	8.3	79.0
Montana .....	8,970	8,043	3,706	927	11.5	117.0
Nebraska .....	1,852	1,932	214	-80	-4.1	802.8
Nevada .....	2,406	1,900	1,107	500	26.2	63.3
New Mexico .....	12,795	7,884	3,085	4,911	62.3	155.6
North Dakota .....	69	54	7	15	( <sup>2</sup> )	( <sup>2</sup> )
Oklahoma .....	137	124	.....	13	10.5	.....
Oregon .....	6,669	4,636	3,150	2,033	43.9	47.2
South Dakota .....	500	906	189	-106	-17.5	220.6
Texas <sup>3</sup> .....	4,150	1,252	623	2,898	231.5	101.0
Utah .....	19,709	17,924	9,724	1,785	10.0	84.3
Washington .....	7,604	3,280	1,040	4,378	133.2	214.1
Wyoming .....	6,297	3,721	1,917	2,570	69.2	94.1

<sup>1</sup> A minus sign (—) denotes decrease.

<sup>2</sup> Per cent not calculated when base is less than 100.

<sup>3</sup> Exclusive of farms irrigated for rice growing.

The total number of farms on which irrigation was practiced in 1909 was 158,713. California contained the largest number of such farms, having about one-fourth (24.8 per cent) of the total number, and Colorado the next largest number, nearly one-sixth (16.3 per cent) of the total, while Utah ranked third in this respect, with about one-eighth (12.4 per cent) of the total.

The percentage of increase between 1889 and 1899 in the number of farms irrigated was more than double that during the succeeding decade, but the absolute

increases during the two decades were approximately equal. Nebraska showed the largest percentage of increase during the former period and Texas during the latter period, but in neither state is the actual number of irrigated farms large. In Nebraska and South Dakota there were decreases between 1899 and 1909. The largest absolute increase in both decades was in California. In the period 1899 to 1909 the next largest increase was in Colorado, and in the period 1889 to 1899 in Utah.

**Acreage irrigated.**—Table 3 gives, by states, the acreage irrigated in the arid region in 1909, 1899, and 1889, respectively, with the percentage of increase in each decade.

STATE.	ACREAGE IRRIGATED.					
	1909	1899	1889	Increase.		
				1899-1909		1889-1899
				Amount.	Per cent.	Per cent.
Total .....	13,738,485	7,518,527	3,631,381	6,219,958	82.7	107.0
Arizona .....	320,051	185,396	65,821	134,655	72.6	181.7
California .....	2,664,104	1,445,872	1,004,233	1,218,232	84.3	44.0
Colorado .....	2,792,032	1,611,271	890,735	1,180,761	73.3	80.9
Idaho .....	1,430,848	602,568	217,005	828,280	137.5	177.7
Kansas .....	37,479	23,620	20,818	13,859	58.7	13.5
Montana .....	1,679,084	951,154	350,582	727,930	76.5	171.3
Nebraska .....	255,950	148,538	11,744	107,412	72.3	1,104.8
Nevada .....	701,833	504,168	224,403	197,665	39.2	124.7
New Mexico .....	461,718	203,893	91,745	257,825	126.5	122.2
North Dakota .....	10,248	4,872	445	5,376	110.3	994.8
Oklahoma .....	4,388	2,759	.....	1,629	59.0	.....
Oregon .....	686,129	388,310	177,944	297,819	76.7	118.2
South Dakota .....	63,248	43,676	15,717	19,572	44.8	177.9
Texas <sup>1</sup> .....	164,283	40,952	18,241	123,331	301.2	124.5
Utah .....	999,410	629,293	263,473	370,117	58.8	138.8
Washington .....	334,378	126,307	48,799	208,071	164.7	158.8
Wyoming .....	1,133,302	605,878	229,676	527,424	87.1	163.8

<sup>1</sup> Exclusive of land irrigated for rice growing.

## ABSTRACT OF THE CENSUS—AGRICULTURE.

The total acreage reported as irrigated in 1909 was 13,738,485, an increase of 6,219,958 acres, or 82.7 per cent, as compared with 1899. The increase in the preceding decade was 3,887,146 acres, or 107 per cent.

In total acreage irrigated California ranked first in 1889, Colorado second, and Montana third. In both 1899 and 1909 Colorado reported the largest irrigated acreage, while California and Montana were second and third, respectively. Idaho followed closely in 1909. From 1899 to 1909 California showed the largest absolute increase, followed by Colorado, Idaho,

and Montana in the order named. In percentage of increase for this decade, however, Texas ranked first, Washington second, Idaho third, and New Mexico fourth.

Acreage irrigated in 1909, acreage enterprises were capable of irrigating in 1910, and acreage included in projects.—In Table 4 data as to the acreage irrigated in 1909, the acreage enterprises were capable of irrigating in 1910, and the acreage included in projects are presented, with classification according to the type of enterprise.

STATE.	ALL CLASSES OF ENTERPRISES.			U. S. RECLAMATION SERVICE.			U. S. INDIAN SERVICE.			CAREY ACT ENTERPRISES.		
	Acreage irrigated in 1909.	Acreage enterprises were capable of irrigating in 1910.	Acreage included in projects.	Acreage irrigated in 1909.	Acreage enterprises were capable of irrigating in 1910.	Acreage included in projects.	Acreage irrigated in 1909.	Acreage enterprises were capable of irrigating in 1910.	Acreage included in projects.	Acreage irrigated in 1909.	Acreage enterprises were capable of irrigating in 1910.	Acreage included in projects.
<b>Total.....</b>	<b>13,738,485</b>	<b>19,334,697</b>	<b>31,111,142</b>	<b>395,046</b>	<b>786,190</b>	<b>1,973,016</b>	<b>172,912</b>	<b>376,576</b>	<b>879,068</b>	<b>288,553</b>	<b>1,089,677</b>	<b>2,573,374</b>
Arizona.....	320,051	387,655	944,090	138,364	164,500	270,000	19,386	20,974	36,017	.....	.....	.....
California.....	2,664,104	3,619,378	5,490,360	400	1,200	14,200	3,490	3,490	3,800	.....	.....	.....
Colorado.....	2,792,032	3,990,166	5,917,457	16,600	80,000	163,000	1,020	2,020	20,020	485	6,085	59,480
Idaho.....	1,430,543	2,388,959	3,549,573	47,500	113,000	295,000	3,426	21,540	51,540	162,418	742,618	1,098,661
Kansas.....	37,479	139,995	161,300	6,953	.....	10,677	.....	.....	.....	.....	.....	.....
Montana.....	1,679,084	2,205,155	3,515,002	14,077	85,245	113,744	67,417	114,340	440,940	9,648	49,500	306,097
Nebraska.....	255,950	429,225	680,133	30,536	60,241	107,520	.....	300	600	.....	.....	.....
Nevada.....	701,833	840,962	1,232,142	30,000	90,185	216,185	2,597	3,381	18,000	.....	.....	.....
New Mexico.....	461,718	644,970	1,102,297	13,398	21,467	30,267	24,007	24,743	37,455	.....	.....	16,000
North Dakota.....	10,248	21,917	38,173	1,610	12,090	24,480	.....	.....	.....	.....	.....	.....
Oklahoma.....	4,388	6,397	8,528	.....	.....	.....	.....	.....	.....	.....	.....	.....
Oregon.....	686,129	830,526	2,527,208	22,000	45,319	135,000	429	439	879	24,750	65,500	633,264
South Dakota.....	63,248	128,481	201,025	5,613	47,668	101,967	50	50	100	.....	.....	.....
Texas <sup>1</sup> .....	164,283	340,641	753,099	.....	.....	.....	11,520	86,600	106,000	5,000	20,000	43,000
Utah.....	999,410	1,250,240	1,947,625	.....	.....	.....	.....	.....	.....	.....	.....	.....
Washington.....	334,378	470,514	817,032	55,690	74,500	143,096	35,000	50,000	100,000	.....	.....	.....
Wyoming.....	1,138,392	1,639,510	2,224,298	12,005	34,800	167,880	4,270	48,699	63,667	86,252	206,974	426,472

  

STATE.	IRRIGATION DISTRICTS.			COOPERATIVE ENTERPRISES.			INDIVIDUAL AND PARTNERSHIP ENTERPRISES.			COMMERCIAL ENTERPRISES.		
	Acreage irrigated in 1909.	Acreage enterprises were capable of irrigating in 1910.	Acreage included in projects.	Acreage irrigated in 1909.	Acreage enterprises were capable of irrigating in 1910.	Acreage included in projects.	Acreage irrigated in 1909.	Acreage enterprises were capable of irrigating in 1910.	Acreage included in projects.	Acreage irrigated in 1909.	Acreage enterprises were capable of irrigating in 1910.	Acreage included in projects.
<b>Total.....</b>	<b>528,642</b>	<b>800,451</b>	<b>1,581,465</b>	<b>4,643,639</b>	<b>6,191,577</b>	<b>8,830,197</b>	<b>6,257,387</b>	<b>7,666,110</b>	<b>10,153,545</b>	<b>1,451,806</b>	<b>2,424,116</b>	<b>5,119,977</b>
Arizona.....	.....	.....	.....	101,025	120,559	300,639	61,196	81,422	175,834	80	200	1,600
California.....	173,793	294,108	600,351	779,020	984,570	1,388,435	961,136	1,131,951	1,512,511	746,205	1,204,059	1,965,043
Colorado.....	115,304	207,570	487,370	1,273,141	1,870,447	2,436,367	1,226,025	1,581,941	2,039,533	150,457	292,103	681,687
Idaho.....	140,930	177,900	329,796	628,102	782,603	993,746	403,600	483,946	676,508	44,872	67,352	104,322
Kansas.....	.....	.....	.....	27,372	135,200	144,200	3,154	4,705	6,423	.....	.....	.....
Montana.....	412	6,640	6,640	333,926	373,022	518,209	1,191,060	1,405,513	1,082,220	62,544	80,895	140,852
Nebraska.....	76,448	77,228	91,076	78,005	168,290	240,009	45,227	64,472	86,305	24,834	52,724	154,623
Nevada.....	.....	.....	.....	78,966	88,255	120,269	581,406	640,841	844,128	8,864	9,800	24,500
New Mexico.....	.....	.....	16,400	251,911	355,327	482,054	144,212	185,283	295,171	28,190	58,150	224,950
North Dakota.....	.....	.....	.....	.....	.....	.....	8,638	9,821	13,693	.....	.....	.....
Oklahoma.....	.....	.....	.....	2,000	3,000	3,600	2,388	3,397	5,028	.....	.....	.....
Oregon.....	1,500	1,500	5,980	149,985	169,944	309,632	410,078	454,074	619,986	77,387	93,750	602,467
South Dakota.....	.....	.....	.....	13,091	18,243	22,687	37,684	55,820	69,971	6,300	6,800	6,900
Texas <sup>1</sup> .....	.....	.....	.....	41,186	75,011	146,795	49,657	65,286	104,044	73,440	200,344	502,860
Utah.....	.....	.....	.....	637,260	790,855	1,259,351	222,448	267,266	376,502	64,727	87,070	151,970
Washington.....	.....	.....	.....	81,122	90,805	116,410	95,655	117,145	192,310	66,911	138,064	266,216
Wyoming.....	11,800	27,050	27,050	116,317	165,476	189,894	813,823	1,024,137	1,153,378	87,935	133,305	195,967

<sup>1</sup> Exclusive of land irrigated for rice growing.

The enterprises were reported in 1910 as capable of irrigating 19,334,697 acres, which is 5,596,212 acres in excess of the acreage actually irrigated in 1909. This excess shows the extent to which the irrigated area can be enlarged without the construction of additional works. It does not, however, represent land available for settlement in the latter year, as much of the land that was under ditch in 1910 but not irri-

gated in 1909 was already taken up, being in farms not completely under cultivation. The excess acreage lies principally in Colorado, Idaho, California, Montana, and Wyoming, these states ranking in the order named in this respect.

The acreage included in projects which were either completed or under way July 1, 1910, as reported by the various enterprises—31,111,142—was 17,372,657

acres greater than the acreage irrigated in 1909. The figure would indicate the amount by which the irrigated acreage may be extended upon the completion of existing enterprises, were it not probable that the owners of these enterprises in some cases have overestimated what they can accomplish. It is certain, however, that much additional land will later be provided with a water supply by works that were in process of construction in 1910. The amount of excess of the acreage included in projects over that irrigated in 1909 is also greatest in the states named in the preceding paragraph and in Oregon.

Table 5 shows by percentages the relative importance of the several classes of enterprises as judged by acreage.

CLASS OF ENTERPRISE.	PER CENT OF TOTAL FOR ARID REGION.		
	Acreage irrigated in 1909.	Acreage enterprises were capable of irrigating in 1910.	Acreage included in projects.
All classes.....	100.0	100.0	100.0
U. S. Reclamation Service.....	2.9	4.1	8.3
U. S. Indian Service.....	1.3	1.9	2.8
Carey Act enterprises.....	2.1	5.0	8.3
Irrigation districts.....	3.8	4.1	5.1
Cooperative enterprises.....	33.8	32.0	28.4
Individual and partnership enterprises.....	45.5	39.0	32.6
Commercial enterprises.....	10.6	12.5	10.5

Nearly one-half (45.5 per cent) of the acreage irrigated in 1909 was served by individual and partnership enterprises, and about one-third (33.8 per cent) by

cooperative enterprises, which are controlled by the water users. Irrigation districts, which served 3.8 per cent, are also controlled by the water users. Thus about 83 per cent of the acreage irrigated in 1909 received a water supply from works controlled by the water users. United States Reclamation Service and Carey Act enterprises, which irrigated 2.9 per cent and 2.1 per cent, respectively, of this total acreage, are to be turned over to the water users when the rights are paid for, and many of the commercial enterprises are operating under a similar arrangement.

Acreage irrigated, classified by source of water supply.—In Table 6 the acreage irrigated in the arid region in 1909 is classified according to the source of the water supply. Where a supply is received from more than one source, the land is classified under the source from which the principal supply is derived. In the aggregate considerable areas are supplied with water from more than one source. Thus, in California, large areas receive water both by gravity diversion from streams and by pumping from wells, while in Texas some of the newer canals on the Rio Grande receive water by gravity when the river is high and by pumping when the river is low. In both instances most of this land is classed with the acreage that received water by gravity from streams. The only reservoirs which are treated as independent sources of supply are those filled by collecting storm water or from watercourses which are ordinarily dry. When reservoirs are filled from streams or wells, the primary source is considered the source of supply.

Table 6

Table 6	ACREAGE IRRIGATED IN 1909.										
	STATE.	Total.	Supplied from—							Total irrigated with pumped water.	
			Streams.		Wells.		Reser-voirs.	Lakes.			Springs.
			By gravity.	By pumping.	Flowing.	By pumping.		By gravity.	By pumping.		
Total .....	13,738,465	12,763,797	157,775	144,400	307,496	98,193	58,284	12,354	196,186	477,625	
Arizona.....	320,051	300,067	7,711	1,489	6,066	487	570		3,631	13,807	
California.....	2,604,104	2,216,757	29,965	74,128	276,595	16,410	15,896	2,574	31,779	309,134	
Colorado.....	2,702,032	2,745,035	13,248	5,171	3,111	16,091	422	634	8,320	16,993	
Idaho.....	1,430,848	1,883,718	18,055	1,172	705	732	4,622	1,535	19,679	20,925	
Kansas.....	37,479	35,469	20	2	1,959	2			27	1,979	
Montana.....	1,679,084	1,624,656	7,903	207	55	22,614	5,617	5	17,967	8,023	
Nebraska.....	255,950	254,105	18		139	1,002			686	157	
Nevada.....	701,833	681,299	463	150	37	138	500	406	38,840	909	
New Mexico.....	461,718	397,059	1,533	48,877	5,952	1,272	862		6,163	7,485	
North Dakota.....	10,248	7,153	1,614		1	1,280			200	1,615	
Oklahoma.....	4,388	4,205	50		69	20	28		16	119	
Oregon.....	686,129	643,281	3,585	655	805	3,279	22,915	821	10,788	5,211	
South Dakota.....	63,248	47,122	540	1,448	8	13,535	200		395	548	
Texas.....	164,283	75,496	59,196	3,710	6,152	6,203	163	295	13,068	65,643	
Utah.....	999,410	954,800	2,559	4,100	300	568	1,671		35,412	2,859	
Washington.....	334,378	301,341	9,085	3,227	5,437	299	4,698	6,084	4,207	20,606	
Wyoming.....	1,133,302	1,112,234	1,540	64	75	14,261	120		5,008	1,615	

Exclusive of land irrigated for rice growing.

More than nine-tenths (92.9 per cent) of the acreage irrigated in 1909 was supplied with water by gravity diversion from streams, and, including cases where water was pumped, streams constituted the source of supply for 94.1 per cent of the total acreage irrigated. Wells supplied the next largest acreage, 3.3 per cent of the total, about one-third of this acreage being watered

by flowing wells. Springs furnished the supply for 1.4 per cent of the total acreage irrigated, and reservoirs and lakes each for less than 1 per cent. Of the total acreage irrigated from wells, California contained 77.6 per cent, and New Mexico 12.1 per cent. In the case of the other sources of supply the acreage irrigated was more generally distributed among the states.

## IRRIGATION WORKS.

Number of enterprises and number and length of ditches.—Table 7 shows the number of irrigation enterprises, and the number and length of main and lateral ditches, respectively, reported in 1910. It should be borne in mind that some lateral ditches are much larger than some main ditches, and that the distinction is more or less arbitrary.

STATE.	Number of enterprises.	DITCHES.					
		Number.			Length (miles).		
		Total.	Main ditches.	Laterals.	Total.	Main ditches.	Laterals.
<b>Total.....</b>	<b>54,700</b>	<b>81,837</b>	<b>45,720</b>	<b>36,117</b>	<b>125,591</b>	<b>87,529</b>	<b>38,062</b>
Arizona.....	1,269	1,204	891	313	2,597	1,727	870
California.....	13,970	14,733	8,590	6,143	21,129	12,020	8,509
Colorado.....	9,065	14,017	8,405	5,612	22,670	17,564	5,006
Idaho.....	3,092	6,568	3,209	3,359	12,759	7,662	5,097
Kansas.....	716	128	89	39	316	274	42
Montana.....	5,534	14,980	6,673	8,307	18,934	12,990	5,944
Nebraska.....	474	1,458	420	1,038	2,728	1,459	1,269
Nevada.....	1,347	2,525	994	1,531	3,151	1,938	1,213
New Mexico.....	2,786	3,381	2,101	1,280	5,854	4,664	1,190
North Dakota.....	49	93	47	46	126	52	74
Oklahoma.....	114	153	47	106	85	54	31
Oregon.....	3,745	6,100	3,582	2,518	7,691	5,539	2,052
South Dakota.....	395	680	348	332	1,256	631	625
Texas <sup>1</sup> .....	2,161	1,252	636	616	1,663	941	722
Utah.....	2,472	3,852	2,495	1,357	7,709	5,887	1,822
Washington.....	1,934	2,780	1,600	1,180	3,892	2,594	1,298
Wyoming.....	5,577	7,933	5,598	2,340	13,231	10,933	2,298

<sup>1</sup> Exclusive of enterprises supplying water for the irrigation of rice.

Reservoirs.—Table 8 gives, by states, the number and capacity of reservoirs used for irrigation in 1910. The acre-foot, used to express capacity, is the quantity of water required to cover 1 acre to the depth of 1 foot, or 43,560 cubic feet. Most of these reservoirs are filled from streams during flood season and in the winter, the stored water being used in the late summer on land which receives its earlier supply by gravity diversion from streams. Some, however, store storm water flowing in drainage channels which are ordinarily dry.

STATE.	RESERVOIRS.	
	Number.	Capacity (acre-feet).
<b>Total.....</b>	<b>6,812</b>	<b>12,581,129</b>
Arizona.....	402	1,349,938
California.....	1,583	743,269
Colorado.....	1,084	2,646,563
Idaho.....	243	1,742,303
Kansas.....	42	31,024
Montana.....	827	580,261
Nebraska.....	44	2,098
Nevada.....	109	325,953
New Mexico.....	522	454,162
North Dakota.....	22	132,187
Oklahoma.....	11	12,222
Oregon.....	271	1,024,266
South Dakota.....	314	216,206
Texas <sup>1</sup> .....	288	72,051
Utah.....	480	588,317
Washington.....	156	121,543
Wyoming.....	414	2,550,937

<sup>1</sup> Exclusive of reservoirs supplying water for the irrigation of rice.

Wells.—Table 9 shows the number and capacity of flowing and pumped wells used for irrigation in 1910. The capacities reported are estimates made by the owners, and are often not very accurate, as few well owners have facilities for measuring the discharge of wells. In the case of pumped wells many of the statements of capacity are based on the estimated pump capacity, the capacity of the wells themselves never having been tested.

STATE.	WELLS.			
	Flowing.		Pumped.	
	Number.	Capacity (gallons per minute).	Number.	Capacity (gallons per minute).
<b>Total.....</b>	<b>5,070</b>	<b>1,345,596</b>	<b>14,558</b>	<b>5,426,139</b>
Arizona.....	214	9,953	470	765,921
California.....	2,361	477,343	10,724	4,119,675
Colorado.....	313	41,989	121	53,564
Idaho.....	62	7,200	24	2,826
Kansas.....	3	30	939	73,362
Montana.....	15	22,185	10	5,263
Nebraska.....	—	—	66	3,363
Nevada.....	19	1,302	6	1,349
New Mexico.....	673	669,238	466	190,000
North Dakota.....	—	—	1	15
Oklahoma.....	—	—	65	1,791
Oregon.....	51	3,035	92	20,883
South Dakota.....	42	14,382	4	24
Texas <sup>1</sup> .....	122	36,930	1,412	121,031
Utah.....	1,138	42,794	27	4,827
Washington.....	55	18,926	128	60,220
Wyoming.....	2	250	3	835

<sup>1</sup> Exclusive of wells supplying water for the irrigation of rice.

Pumping plants.—Table 10 gives the number of pumping plants used for irrigation in 1910, with the capacities of power plants and pumps. The capacities are given as reported by the owners, and in most cases represent the rated capacities claimed by the manufacturers of the apparatus, which are probably in excess of the capacities obtained in use under ordinary field conditions.

STATE.	PUMPING PLANTS.		
	Number.	Capacity of power plants (horse-power).	Capacity of pumps (gallons per minute).
<b>Total.....</b>	<b>13,906</b>	<b>243,435</b>	<b>9,947,909</b>
Arizona.....	429	37,258	851,878
California.....	9,297	128,143	5,276,236
Colorado.....	206	7,969	236,937
Idaho.....	58	7,065	278,509
Kansas.....	608	1,517	128,276
Montana.....	125	3,511	281,190
Nebraska.....	76	140	5,366
Nevada.....	18	693	24,295
New Mexico.....	413	14,226	216,355
North Dakota.....	4	2,033	182,115
Oklahoma.....	68	107	4,541
Oregon.....	229	3,095	113,514
South Dakota.....	8	63	5,289
Texas <sup>1</sup> .....	1,784	20,915	1,455,285
Utah.....	60	2,143	315,057
Washington.....	391	13,847	365,411
Wyoming.....	34	705	142,529

<sup>1</sup> Exclusive of plants supplying water for the irrigation of rice.



## COST.

Table 11 gives, by states, the total cost of irrigation enterprises in the arid region as reported at the Eleventh, Twelfth, and Thirteenth Censuses, and also the

estimated final cost of enterprises which were either completed or under way on July 1, 1910, the date of the census of irrigation of 1910.

Table 11

Table 11	COST OF IRRIGATION ENTERPRISES.							
	STATE.	1910		1899	1889	Increase.		
		Estimated final cost.	Cost to July 1.			1899-1910 <sup>1</sup>		1889-1899
						Amount.	Per cent.	Percent.
Total.....	\$424,281,186	\$307,866,369	\$66,962,275	<sup>2</sup> \$29,611,000	\$240,904,094	359.8	126.1	
Arizona.....	24,828,808	17,077,966	4,438,352	465,000	13,239,614	298.3	854.5	
California.....	84,392,344	72,530,030	19,181,610	13,005,000	53,398,420	278.4	47.5	
Colorado.....	76,443,239	56,636,443	11,758,703	6,369,000	44,877,740	381.7	84.6	
Idaho.....	58,451,106	40,977,088	5,120,399	1,029,000	35,857,289	700.3	397.6	
Kansas.....	1,366,503	1,366,503	529,755	( <sup>3</sup> )	835,808	157.8	.....	
Montana.....	32,382,077	22,970,958	4,633,073	1,623,000	18,287,885	390.5	188.5	
Nebraska.....	9,485,231	7,708,310	1,310,698	( <sup>3</sup> )	6,487,612	495.0	.....	
Nevada.....	12,188,756	6,721,924	1,537,559	1,251,000	5,184,365	337.2	22.9	
New Mexico.....	11,640,091	9,164,897	4,165,312	512,000	4,989,585	119.8	713.5	
North Dakota.....	836,482	836,482	16,980	( <sup>3</sup> )	819,502	4,826.3	.....	
Oklahoma.....	47,200	47,200	21,872	.....	25,328	116.8	.....	
Oregon.....	39,216,619	12,760,214	1,843,771	826,000	10,916,443	592.1	123.2	
South Dakota.....	3,806,556	3,043,140	284,747	( <sup>3</sup> )	2,758,393	968.7	.....	
Texas <sup>4</sup> .....	8,613,533	7,346,708	705,608	( <sup>3</sup> )	6,641,100	941.2	.....	
Utah.....	17,840,775	14,023,717	5,865,302	2,780,000	8,163,415	139.2	111.0	
Washington.....	22,322,856	16,219,149	1,525,369	197,000	14,693,780	963.3	674.3	
Wyoming.....	20,425,890	17,700,980	3,973,165	1,281,000	13,727,815	345.5	210.2	

<sup>1</sup> Increase computed on the basis of the cost to July 1, 1910.

<sup>2</sup> Includes \$273,000 for Kansas, Nebraska, North Dakota, South Dakota, and Texas, which are not shown separately in the report of the census of 1890, these five states being grouped under the designation of "subhumid region."

<sup>3</sup> Separate figures not available.

<sup>4</sup> Exclusive of enterprises supplying water for the irrigation of rice.

The cost of irrigation enterprises up to July 1, 1910, as reported at the Thirteenth Census, includes the cost of construction, the cost of acquiring rights, and any added costs incident to construction, such as the purchase of land for rights of way, the building of structures for use in operation and maintenance, and engineering and legal expenses. For all of the larger enterprises the cost is that given by the owners, but it is probable that in many cases this is estimated rather than taken from actual accounts. For some of the smaller enterprises the cost was estimated by the special agents of the Census Bureau, and in the case of some schedules received by mail the cost has been estimated in the bureau on the basis of the average cost per acre for other enterprises of the same class in the same vicinity. Many of the smaller ditches were built a number of years ago by their owners without the expenditure of much, if any, money, and many of these have since changed hands. In such cases the cost given by the present owners is only a rough estimate. The data as to cost reported for 1899 and 1889 are probably somewhat less accurate than those for 1910. The figure for cost given in the Twelfth Census report is designated as the "cost of construction of systems operated in 1899." The figure for cost at the Eleventh Census is an estimate consisting of the sum of the amounts obtained by multiplying the acreage irrigated by the average first cost per acre of obtaining water, or of water rights, as given by the irrigators. Although not specifically stated in the reports for the

previous censuses, it is probable that the figures there given include the same items represented in the figure for cost in 1910.

The total cost of irrigation enterprises up to July 1, 1910, was reported as \$307,866,369, which represents an increase of \$240,904,094, or 359.8 per cent over the cost reported at the census of 1900. In no state in the arid region was the increase in cost for this period less than 100 per cent, the highest percentage of increase being in North Dakota and the lowest in Oklahoma. With respect to absolute increase California ranked first, Colorado second, Idaho third, and Montana fourth. The year 1910 was in the midst of a period of great activity in the construction of irrigation works, and on July 1, 1910, a large number of works were incomplete. The "estimated final cost" reported, \$424,281,186, is the sum of the cost up to July 1 and the estimated cost of completing these unfinished works.

Average cost per acre.—Table 12 gives the average cost of irrigation enterprises per acre. The averages for 1889 and 1899 are, with one exception, for the acreage actually irrigated in the respective years. These averages are probably considerably higher than if they had been calculated on the basis of the acreage the enterprises were capable of irrigating. At the Thirteenth Census the average cost per acre has been computed by dividing the cost to July 1, 1910, by the acreage which enterprises were capable of irrigating in 1910. Averages based on the acreage irrigated in 1909 and the cost

to July 1, 1910, are, however, also presented as a rough basis for comparison with the averages for the previous censuses. In addition, averages based on the estimated final cost of enterprises and the acreage which their owners expect finally to be able to supply with water are given. These latter averages would represent most accurately the true cost of providing works to supply water for irrigation, were it not for a more or less general tendency to underestimate cost and overestimate the acreage it will be possible to serve.

Table 12

AVERAGE COST OF IRRIGATION ENTERPRISES PER ACRE.

STATE.	1910			1899	1889
	Based on cost to July 1, 1910, and acreage enterprises were capable of irrigating in 1910.	Based on cost to July 1, 1910, and acreage irrigated in 1909.	Based on estimated final cost and acreage included in projects.		
<b>Total</b> .....	\$15.92	\$22.41	\$13.64	\$8.91	\$8.15
Arizona.....	45.00	55.23	26.30	23.94	7.07
California.....	20.05	27.24	15.37	13.27	12.95
Colorado.....	14.19	20.29	12.92	7.30	7.15
Idaho.....	17.15	28.64	10.47	13.79	4.74
Kansas.....	9.75	36.44	8.47	22.43	(2)
Montana.....	10.42	13.68	9.21	4.92	4.63
Nebraska.....	18.17	30.47	13.95	3.82	(2)
Nevada.....	7.99	9.58	9.89	3.05	7.58
New Mexico.....	14.19	19.83	10.55	20.43	5.58
North Dakota.....	38.17	31.62	21.01	3.49	(2)
Oklahoma.....	7.38	10.76	5.53	7.93	4.64
Oregon.....	15.36	18.00	15.52	4.76	(2)
South Dakota.....	23.60	43.11	18.85	6.52	(2)
Texas <sup>1</sup> .....	21.57	44.72	11.43	17.23	(2)
Utah.....	11.22	14.04	9.16	9.32	10.55
Washington.....	34.47	48.51	27.32	12.08	4.03
Wyoming.....	10.80	15.62	9.18	6.0	3.62

<sup>1</sup> Based on acreage under ditch in 1890.

<sup>2</sup> Figures for Kansas, Nebraska, North Dakota, South Dakota, and Texas are not shown separately in the report of the census of 1890, these five states being grouped under the designation of "subhumid region." The average for the subhumid region was \$4.07.

<sup>3</sup> Exclusive of land irrigated for rice growing.

The average cost per acre based on the acreage irrigated in 1909 was \$22.41; that based on the acreage enterprises were capable of irrigating in 1910 was \$15.92; and that based on the estimated total cost and the acreage included in projects was \$13.64.

Between 1889 and 1899 there was no marked increase in the average cost of irrigation enterprises per acre of land irrigated, but in 1910 the average cost per acre was very much higher. The chief reason for this is the fact that, naturally, irrigation enterprises were first undertaken where water could be most easily secured and engineering difficulties were least serious. The enterprises undertaken during more recent years have been of necessity on a much larger scale than those built formerly, and, in most cases, of a better and more permanent type of construction. Indeed, much of the cost incurred between 1899 and 1910 was for the im-

provement of existing works, especially by the addition of reservoirs, which did not provide water for new lands, but rather provided a better supply for land already irrigated.

**Average cost per acre, by type of enterprise.**—Table 13 gives the average cost of irrigation enterprises per acre in 1910, computed in the three ways just shown, for each class of enterprises.

Table 13

AVERAGE COST OF IRRIGATION ENTERPRISES PER ACRE.

CLASS OF ENTERPRISE.	Based on cost to July 1, 1910, and acreage enterprises were capable of irrigating in 1910.	Based on cost to July 1, 1910, and acreage irrigated in 1909.	Based on estimated final cost and acreage included in projects.
<b>All classes</b> .....	\$15.92	\$22.41	\$13.64
U. S. Reclamation Service.....	67.52	134.17	48.14
U. S. Indian Service.....	12.78	27.33	13.33
Carey Act enterprises.....	30.53	115.30	21.75
Irrigation districts.....	27.37	41.44	20.33
Cooperative enterprises.....	12.80	17.10	10.67
Individual and partnership enterprises.....	7.09	8.69	5.22
Commercial enterprises.....	24.98	41.71	16.79

The highest average cost per acre on each basis is shown for the United States Reclamation Service enterprises, and the next highest in each case for Carey Act enterprises. Irrigation districts ranked third and commercial enterprises fourth, except in one case where the order is reversed. These four classes comprise the large enterprises which are now engaged in developing new lands, and most of their work is of recent date. The works built by individuals or cooperative enterprises, which are smaller and were for the most part built at an earlier period, naturally utilized the sources from which water could be most readily diverted and transported to the land to be irrigated. The larger works of recent date serve land farther from the streams and involve better, more expensive, and more permanent construction, and as a result the average cost per acre is higher than that for the small works.

**Average cost per acre, by size groups.**—The average cost of irrigation works per acre for enterprises classified by size is shown in Table 14. The classification is based on the acreage intended ultimately to be irrigated.

It will be noted that in general the cost per acre irrigated increases with the size of enterprises. This condition is due at least in a considerable measure to the fact already noted that most of the larger enterprises, which are mainly of recent date, have had to seek water more difficult to obtain than that secured by the smaller enterprises, and that they represent a better type of work.



**Table 14**

	Total.	ENTERPRISES CONTAINING--				
		Less than 25,000 acres.	25,000 to 50,000 acres.	50,000 to 75,000 acres.	75,000 to 100,000 acres.	100,000 acres and over.
Number of enterprises.....	54,700	54,548	74	28	16	34
Acreage:						
Irrigated in 1909.....	13,738,485	11,395,874	\$32,024	412,685	264,006	833,806
Enterprises were capable of irrigating in 1910.....	19,334,697	14,789,465	1,281,145	728,795	493,514	2,041,778
Included in projects.....	31,111,142	20,632,614	2,420,280	1,623,348	1,309,247	5,125,644
Cost:						
To July 1, 1910.....	\$307,866,369	\$175,308,121	\$23,411,977	\$19,524,778	\$14,420,824	\$75,200,669
Estimated final.....	\$424,281,186	\$207,068,121	\$33,154,836	\$33,537,574	\$21,368,421	\$129,152,234
Average cost per acre based on:						
Acreage irrigated in 1909 and cost to July 1, 1910.....	\$22.41	\$15.38	\$28.14	\$47.31	\$54.60	\$90.19
Acreage enterprises were capable of irrigating in 1910 and cost to July 1, 1910.....	\$15.92	\$11.85	\$18.27	\$26.79	\$29.22	\$36.83
Acreage included in projects and estimated final cost.....	\$13.04	\$10.04	\$13.70	\$20.66	\$16.32	\$25.20

Operation and maintenance.—Table 15 gives the average cost per acre for the operation and maintenance of irrigation enterprises in 1909. The inquiry as to this item was not extended to individual and partnership enterprises, for the reason that farmers owning their own ditches usually clean and repair them at odd times without keeping any record of the time or money expended. In the case of some enterprises of other classes, no reports were received. The statistics for cost of operation reported at the two previous censuses, for various reasons, are not fairly comparable with those for 1909, and consequently are not shown in the table.

For the arid region as a whole, the average cost of operation and maintenance per acre irrigated was \$1.07. The abnormal cost shown for North Dakota (\$28.40) relates almost entirely to a single large project which supplied water in 1909 to only a small part of the acreage which it is designed to serve. The lowest average is for Oklahoma (\$0.51 per acre).

**Table 15**

STATE.	Acreage irrigated in 1909 by enterprises for which cost of operation and maintenance was reported.	REPORTED COST OF OPERATION AND MAINTENANCE IN 1909.	
		Amount.	Average per acre for which cost was reported.
Total.....	6,379,955	\$6,828,433	\$1.07
Arizona.....	230,429	214,358	0.93
California.....	1,308,247	2,109,431	1.54
Colorado.....	1,401,670	1,046,268	0.75
Idaho.....	883,098	500,032	0.63
Kansas.....	34,255	54,595	1.59
Montana.....	394,507	349,662	0.89
Nebraska.....	209,023	227,385	1.09
Nevada.....	88,076	80,110	0.97
New Mexico.....	278,439	377,972	1.36
North Dakota.....	1,610	45,718	28.40
Oklahoma.....	1,969	1,000	0.51
Oregon.....	263,855	198,111	0.75
South Dakota.....	25,514	16,288	0.64
Texas <sup>1</sup> .....	109,697	356,260	3.25
Utah.....	689,994	451,283	0.65
Washington.....	176,197	543,312	3.08
Wyoming.....	221,875	190,648	0.86

<sup>1</sup> Exclusive of enterprises supplying water for the irrigation of rice.

## CROPS.

The returns of crops grown on irrigated land, which were made by the regular enumerators of population and agriculture, are somewhat incomplete, for the reason that, owing to the late date at which the provisions of law regarding the irrigation census were passed, the enumerators could not be as carefully instructed regarding the special irrigation schedules as regarding the regular agricultural schedules. On many of the schedules the agricultural enumerators reported land as irrigated but failed to return separately the crops grown on such land. The total acreage of crops reported as raised on irrigated land formed 52.7 per cent of the total acreage irrigated in 1909; and while part of the remainder was doubtless in pasture, it is evident that part was in crops not reported as grown under irrigation and a part was probably in crops not harvested. Although the totals are thus incomplete, the returns are sufficiently accurate to afford reliable averages of yields and values and to show the relative importance of the various crops.

Table 16 gives, by states, the total acreage and total value of crops reported as irrigated in 1909, with the average value per acre.

**Table 16**

STATE.	CROPS IRRIGATED IN 1909.		
	Acreage.	Value.	
		Total.	Average per acre.
Total.....	7,241,561	\$181,617,396	\$25.08
Arizona.....	171,302	4,718,100	27.54
California.....	1,196,767	52,057,007	43.50
Colorado.....	1,650,350	39,478,994	23.92
Idaho.....	772,684	16,582,213	21.46
Kansas.....	22,118	477,025	21.57
Montana.....	909,342	14,535,900	15.99
Nebraska.....	137,211	1,973,880	14.39
Nevada.....	356,079	5,339,475	15.00
New Mexico.....	230,034	5,705,922	24.80
North Dakota.....	3,273	56,215	17.18
Oklahoma.....	2,806	51,995	18.53
Oregon.....	368,911	7,489,255	20.30
South Dakota.....	33,438	606,684	18.16
Texas <sup>1</sup> .....	58,227	2,645,385	45.43
Utah.....	579,744	14,642,792	25.26
Washington.....	160,483	7,994,531	49.82
Wyoming.....	553,786	7,302,953	12.61

<sup>1</sup> Exclusive of rice.

The table shows for all crops reported as irrigated an average value per acre of \$25.08.

The highest average value per acre for crops raised on irrigated land is that for Washington, \$49.82, which

is followed by that for Texas, \$45.43 (exclusive of rice), and that for California, \$43.50. Wyoming showed the lowest average value per acre, \$12.61. As is to be expected, the average value per acre is highest in the states with large areas of fruits, vegetables, and other specialized crops raised by means of irrigation, while in those where forage crops and grains predominate the average is lower. Fruit crops comprised about 12 per cent of the total acreage of irrigated crops in Washington in 1909 and about 21 per cent of the total in California, and vegetables and other special crops about 21 per cent of the total acreage of irrigated crops in Texas, exclusive of rice. In Wyoming, on the other hand, more than 32 per cent of the total acreage of irrigated crops in 1909 was in wild grass, and irrigated fruit crops were insignificant.

Table 17 shows the reported acreage and value of each important irrigated crop in the arid region as a whole, with the percentage of the total represented by each.

CROP.	CROPS IRRIGATED IN 1909.			
	Acreage.		Value.	
	Amount.	Per cent of total.	Amount.	Per cent of total.
Total reported .....	7,241,561	100.0	\$181,617,396	100.0
Alfalfa .....	2,216,628	30.6	50,850,533	28.0
Wild, salt, or prairie grasses .....	1,530,609	21.1	11,734,268	6.5
Oats .....	739,632	10.2	14,055,424	7.7
Wheat .....	548,173	7.6	12,820,982	7.1
Barley .....	240,117	3.3	4,309,445	2.4
Orchard fruits and grapes .....	236,385	3.3	18,245,182	10.0
Other tame or cultivated grasses .....	219,701	3.0	2,571,297	1.4
Grains cut green .....	209,393	2.9	2,992,570	1.6
Timothy alone .....	202,817	2.8	3,211,651	1.8
Sugar beets .....	183,497	2.5	10,511,467	5.8
Timothy and clover mixed .....	183,398	2.5	3,071,535	1.7
Potatoes .....	168,014	2.3	10,085,092	5.6
Corn .....	133,673	1.8	2,423,507	1.3
Tropical and subtropical fruits .....	99,431	1.4	15,344,375	8.4
All other .....	330,183	4.6	19,293,078	10.6

In acreage alfalfa ranked first, with 30.6 per cent of the total reported; "wild, salt, or prairie grasses" second, with 21.1 per cent; and oats third, with 10.2 per cent. Forage crops, taken together, occupied about 63 per cent of the total reported acreage, cereals about 23 per cent, sugar beets 2.5 per cent, potatoes 2.3 per cent, fruit crops about 5 per cent, and the crops such as vegetables, root forage, cotton, buckwheat, and others (grouped under the head "all other") 4.6 per cent.

In value also alfalfa was most important, representing 28 per cent of the total amount reported; but orchard fruits and grapes ranked second in this respect among the crops shown separately and tropical fruits third, notwithstanding the relatively small acreages in these crops.

**Average yields per acre.**—Table 18 shows for each of the leading crops grown on irrigated land the average yield per acre in comparison with the average yield of the same crop on unirrigated land in the United States as a whole. Yields for fruit crops are not given because of the large variety of units in which

these yields were expressed and because the general agricultural schedules do not show the acreage in these crops.

CROP.	AVERAGE YIELD PER ACRE.		EXCESS OF AVERAGE YIELD ON IRRIGATED LAND OVER THAT ON UNIRRIGATED LAND. <sup>1</sup>	
	On irrigated land, arid region.	On unirrigated land, entire United States.	Amount.	Percent.
<b>Cereals:</b>				
Corn .....	23.7	25.9	-2.2	-8.5
Oats .....	36.8	28.5	8.3	29.1
Wheat .....	25.6	15.3	10.3	67.3
Barley .....	29.1	22.3	6.8	30.5
<b>Hay and forage:</b>				
Alfalfa .....	2.94	2.14	0.80	37.4
Timothy alone .....	1.73	1.22	0.51	41.8
Timothy and clover mixed .....	1.82	1.26	0.56	44.4
Other tame or cultivated grasses <sup>2</sup> .....	1.53	1.05	0.48	45.7
Wild, salt, or prairie grasses .....	1.06	1.07	-0.01	-0.9
Grains cut green .....	1.46	1.23	0.23	18.7
<b>Sundry crops:</b>				
Potatoes .....	153.6	103.8	49.8	48.0
Sugar beets .....	11.89	9.73	2.16	22.2

<sup>1</sup> A minus sign (—) indicates that the yield on irrigated land is less than that on unirrigated land.

<sup>2</sup> Includes millet or Hungarian grass.

For each of the crops presented in the table except corn and "wild, salt, or prairie grasses," the average yield on irrigated land exceeds that on unirrigated land, the percentages of excess ranging from 18.7 for grains cut green to 67.3 per cent for wheat. As climatic conditions in the arid region are not favorable to corn, it is not grown to a large extent there. In the case of "wild, salt, or prairie grasses" the average yields on irrigated and unirrigated land are practically equal. A large part of the unirrigated wild grass is cut on river bottom lands where the soil is likely to be wet, even without irrigation, and consequently a difference in favor of irrigated land is not to be expected.

A combined average for all the crops listed in Table 18, each being given a weight corresponding to its acreage, shows an excess yield of 28.6 per cent for the crops grown on irrigated land over those grown on unirrigated land. It is, of course, obvious that this difference in no way represents the advantage of irrigation over nonirrigation. In some sections where rainfall is plentiful irrigation would add little to the yield, but in arid sections often little or nothing can be raised without irrigation.

**Average values per acre.**—The average values per acre of the leading irrigated crops reported for the arid region are shown in Table 19 in comparison with averages for the same crops grown on unirrigated land for the United States as a whole, so far as acreage figures are available for these.

Among crops grown on irrigated land in 1909, tropical fruits led in average value per acre by a wide margin, orchard fruits and grapes ranking second. Potatoes followed the fruit crops, with an average value of \$60.03, and sugar beets were next of the

crops shown separately, the average value being \$57.29 per acre. Alfalfa, the most important irrigated crop, had an average value per acre of \$22.94. In comparing the average values per acre for different crops it should be borne in mind that the crops with higher average values often require more expensive methods of cultivation than those with lower average values.

CROP.	AVERAGE VALUE PER ACRE.		EXCESS OF AVERAGE VALUE FOR IRRIGATED LAND OVER THAT FOR UNIRRIGATED LAND.	
	On irrigated land, arid region.	On unirrigated land, entire United States.	Amount.	Per cent.
Tropical and subtropical fruits	\$154.32	(1)		
Orchard fruits and grapes	77.18	(1)		
Potatoes	60.03	\$44.66	\$15.37	34.4
Sugar beets	57.29	51.90	5.39	10.4
Wheat	23.40	14.75	8.65	58.6
Alfalfa	22.94	16.97	5.97	35.2
Oats	19.00	11.64	7.36	63.2
Barley	18.32	11.81	6.51	55.1
Corn	18.13	14.62	3.51	24.0
Timothy and clover mixed	16.76	13.13	3.63	27.6
Timothy alone	15.84	12.78	3.08	24.1
Grains cut green	14.29	14.26	0.03	0.2
Other tame or cultivated grasses <sup>2</sup>	11.70	10.35	1.35	13.0
Wild, salt, or prairie grasses	7.67	5.06	2.61	51.6
All other	58.43	(3)		

<sup>1</sup> Acreage not reported.

<sup>2</sup> Includes millet or Hungarian grass.

<sup>3</sup> Comparable figure not available.

Each of the crops shown in the table for which comparisons are made had a higher average value per acre for irrigated land than is shown for the same crop grown on unirrigated land for the United States. The excess in favor of the products raised on irrigated land, for the crops included in the comparison, ranged from 0.2 per cent for grains cut green to 63.2 per cent for oats. The average excess for irrigated crops for the crops for which comparative figures are given in the table, based on the total acreages and total values, is about 43 per cent. It should be noted that the comparison just made does not include the crops with the highest average values per acre, such as fruits and vegetables.

**Comparison with preceding census.**—According to the reports of the Twelfth Census the total acreage of irrigated crops in the arid and semiarid states was 5,932,557, while the acreage of such crops reported at the present census of irrigation was 7,241,561, which represents an increase of 22.1 per cent. The fact that this increase is much smaller than the increase in the acreage reported as irrigated (82.7 per cent) is a

further indication that the crop reports of the census of irrigation for 1910 are incomplete. Because of this incompleteness, the crop figures of the two censuses are not compared directly, but in Table 20 the percentage which the acreage in each irrigated crop formed of the total acreage reported in such crops is shown for the two censuses.

CROP.	ACREAGE OF IRRIGATED CROPS.			
	1909		1899	
	Acreage.	Per cent of total.	Acreage.	Per cent of total.
Total reported	7,241,561	100.0	5,932,557	100.0
Alfalfa	2,216,628	30.6	1,617,888	25.6
Wild, salt, or prairie grasses	1,630,669	21.1	997,438	16.8
Oats	789,632	10.2	332,365	5.6
Wheat	648,173	7.6	775,991	13.1
Barley	240,117	3.3	172,228	2.9
Other tame or cultivated grasses <sup>1</sup>	219,701	3.0	306,298	5.2
Grains cut green	209,363	2.9	200,639	3.4
Sugar beets	183,467	2.5	9,074	0.2
Potatoes	168,014	2.3	90,991	1.5
Corn	133,673	1.8	149,799	2.5
Tropical and subtropical fruits	99,431	1.4	87,071	1.5
Rye	6,054	0.1	7,096	0.1
All other	946,639	13.1	1,285,679	21.7

<sup>1</sup> Includes millet or Hungarian grass.

From Table 20 it appears that at both censuses alfalfa was the leading crop grown under irrigation, but that it occupied a considerably larger proportion of the total acreage reported for irrigated crops in 1909 than in 1899. The crop next in importance in respect to acreage in both years was "wild, salt, or prairie grasses," which likewise comprised a larger percentage of the total in 1909 than in 1899. Oats was third in acreage in 1909, followed by wheat, while in 1899 wheat ranked third and oats fourth. Oats covered a much larger percentage of the total acreage of irrigated crops in 1909 than in 1899 and wheat a much smaller percentage in the later than in the earlier year.

The most notable relative increase was for sugar beets, the growing of this crop in the irrigated region being largely a development of the last decade. Potatoes also showed a marked increase in relative importance. Tropical and subtropical fruits occupied about the same place in the two censuses. From a comparison of Table 20 with Table 19, it will be seen that, with the exception of "wild, salt, or prairie grasses," the irrigated crops which are increasing in acreage most rapidly are all among the crops with relatively high values per acre.

#### IRRIGATION FOR RICE GROWING.

As previously stated, the special inquiry into irrigation for rice growing was confined to the rice growing districts of Louisiana, Texas, and Arkansas. The data collected, except those relating to crops, are summarized in Table 21.

The number of farms reporting irrigation for rice growing and the acreage irrigated, as reported at the

census of 1910, cover the year 1909, while all other data for that census relate to the year 1910. The reports of the agricultural census of 1910 show that 95.5 per cent of the entire acreage of rice harvested in 1909 was in the three states included in the special irrigation inquiry, and that in all the other states a marked decrease occurred between 1899 and 1909

in the acreage in rice. The figures given in the table for the census of 1910 represent, therefore, in a fairly adequate measure, the extent of irrigation for rice growing in the United States.

The acreage reported on the special irrigation schedules as irrigated for rice growing in 1909 is greater than the total acreage of rice reported in that year on the agricultural schedules for the territory covered. This difference is due principally to the fact that the irrigation schedules show the total acreage watered, while the agricultural schedules show only the acreage harvested. A considerable acreage planted in rice in 1909 was not harvested because of poor stand, shortage of water, and damage by storms.

Table 21	Total for specified states.	Louisiana.	Texas.	Arkansas.
Number of farms reporting irrigation for rice growing.....	4,010	2,690	1,088	232
Acreage irrigated for rice growing.....	694,800	380,200	286,847	27,753
Acreage enterprises were capable of irrigating in 1910.....	950,706	553,220	350,350	47,136
Acreage included in projects.....	1,134,322	581,065	499,474	52,883
Number of enterprises.....	2,158	1,237	611	310
Total length of ditches.....miles..	2,339	1,168	1,040	131
Length of main ditches.....miles..	1,398	729	538	131
Length of lateral ditches.....miles..	941	439	502	.....
Reservoirs:				
Number.....	144	104	21	19
Capacity.....acre-feet..	21,795	10,482	2,310	3
Flowing wells:				
Number.....	1	.....	1	.....
Capacity.....gals. per min..	80	.....	80	.....
Pumped wells:				
Number.....	1,413	606	500	307
Capacity.....gals. per min..	1,822,560	1,108,230	445,495	268,829
Pumping plants:				
Number.....	1,897	1,007	575	315
Capacity of power plants, horsepower.....	113,045	57,426	48,179	12,440
Capacity of pumps, gals. per min..	9,407,955	5,064,173	3,907,380	430,402
Cost of irrigation enterprises to July 1, 1910.....	\$13,587,639	\$6,859,166	\$6,140,639	\$687,834
Average cost per acre <sup>1</sup> .....	\$14.29	\$12.40	\$17.53	\$12.47
Estimated final cost of existing enterprises.....	\$13,667,639	\$6,914,166	\$6,140,639	\$612,834
Average cost per acre <sup>2</sup> .....	\$12.05	\$11.88	\$12.29	\$11.59

<sup>1</sup> Based on acreage enterprises were capable of irrigating in 1910.

<sup>2</sup> Based on acreage included in projects.

The total acreage irrigated for rice growing in the three states in 1909 was 694,800, of which 54.7 per cent was in Louisiana, 41.3 per cent in Texas, and 4 per cent in Arkansas. The enterprises which were completed or under way in 1910 were reported as capable of irrigating 950,706 acres in that year and of serving ultimately a total of 1,134,322 acres.

The total cost of irrigation enterprises to July 1, 1910, was \$13,587,639, or an average of \$14.29 per acre for the land to which they were capable of supplying water in 1910. Upon the basis of the acreage irrigated in 1909, the average cost per acre was \$19.56. The estimated total cost of enterprises completed or under way in 1910 was \$13,667,639, or \$12.05 per acre for the land included in these enterprises. From these figures it appears that the works for supplying water for rice irrigation which were under construction in 1910 were relatively insignificant.

In the report on irrigation for the Twelfth Census no information relating to the irrigation of rice in Arkan-

sas is given, because the rice growing industry in that state was insignificant in 1900.

In Table 22 comparisons are made for Louisiana and Texas for the few items that were reported at both censuses. The figures for the Twelfth Census relate to the year 1899.

Table 22	LOUISIANA.			TEXAS.		
	Census of—		Per cent of increase. (1)	Census of—		Per cent of increase.
	1910	1900		1910	1900	
Farms reporting irrigation for rice growing.....	2,690	4,531	-40.6	1,088	78	(2)
Acreage irrigated.....	380,200	201,855	88.5	286,847	8,700	3,197.1
Enterprises.....number.....	1,237	596	107.6	611	(3)	.....
Length of main ditches, (miles).....	729	386	88.9	538	(4)	.....
Cost of irrigation enterprises.....	\$6,859,166	\$2,529,319	171.2	\$6,140,639	\$322,000	1,807.0
Average cost per acre.....	\$12.40	\$12.54	(7)	\$17.53	\$37.01	(7)

<sup>1</sup> A minus sign (—) denotes decrease.

<sup>2</sup> Per cent not calculated when base is less than 100.

<sup>3</sup> Not reported.

<sup>4</sup> Estimated.

<sup>5</sup> Based on cost to July 1, 1910, and acreage enterprises were capable of irrigating in 1910.

<sup>6</sup> Based on cost of systems operated in 1899, and acreage irrigated in that year.

<sup>7</sup> Figures not comparable. (See explanation in text.)

In Louisiana considerable increases have taken place since the census of 1900 in all the items shown in the table except number of farms. The large decrease in the number of farms reporting the irrigation of rice is probably due to the abandonment of rice growing on farms where only small acreages were planted, and an extension of the industry in sections where rice is grown on a larger scale. In Texas almost the entire development has taken place since 1899.

As the figures for average cost of irrigation enterprises per acre at the two censuses are not computed on the same basis, they are not comparable.

Although the crop returns for irrigated rice are not complete, they are sufficiently so to afford reliable averages of the yield and value per acre. These are shown in Table 23.

Table 23	STATE.	RICE GROWN ON IRRIGATED LAND IN 1909.	
		Average yield per acre (bushels).	Average value per acre.
	Louisiana.....	34.6	\$25.70
	Texas.....	38.7	28.64
	Arkansas.....	45.9	41.56

Continuous cropping in rice exhausts the soil, and the districts of Louisiana, where the land has been used for a longer time than in other sections, show the lowest average yield, while Arkansas, where the growing of rice is of comparatively recent date, shows the highest average yield.